

5

axis 13 of the array stretched along the 480 mm length. Four dual polarized, crossed-dipole radiating elements were used. The first radiating element was placed 60 mm from the edge, the second element was placed 120 mm from the first element, the third 120 mm from the second element, and the fourth 120 mm from the third element. The elements were aligned along the vertical axis of the array having slant angles of +45 degrees and -45 degrees with respect to the vertical axis 13 of the array.

Two supports were situated 120 mm from the edges of the ground plane and perpendicular to the vertical axis of the array. The supports were 75 mm tall and had a thin, rectangular parasitic element placed on top. The parasitic element was 5 mm wide and 150 mm long. The parasitic elements were placed at the top of the support and extended along the full length of the support.

Referring now to FIGS. 5 and 6, an array 210 of crossed, dual-dipole radiating elements 202, 203, and 204 are attached to a ground plane 201 to operate in the cellular band of frequencies of 820-960 MHz. As discussed above, the composition and dimensions of the ground plane 201 and the radiating elements 202, 203, and 204 determine the radiation characteristics, beam width, and the impedance of the antennas.

The radiating elements 202, 203, and 204 transmit and receive electromagnetic signal transmissions and are comprised of pairs of dipoles, 211a and 211b, 212a and 212b, and 213a and 213b, respectively. The dipoles comprising the radiating elements 202, 203, and 204 are crossed and configured with 45 degree slant angles (with respect to the axis of the array 215). That is, the axes of the dipoles are arranged such that they are parallel with the polarization sense required. As shown, the slant angles  $+\alpha$  and  $-\alpha$  are +45 degrees and -45 degrees, respectively. Although shown with slant angles of +45 degrees and -45 degrees, it will be understood by those skilled in the art that these angles can be varied to optimize the performance of the antenna. A front side wall 207 and rear side wall 208 contribute to the radiation characteristics of the antenna.

Each of the radiating elements 202, 203, and 204 receive signals having polarizations of +45 degrees and -45 degrees. The received signals from parallel dipoles 211a, 212a, and 213a, or 211b, 212b, and 213b, are combined using a feed network for each polarization. The feed network is composed of coaxial, microstrip, stripline, or other types of transmission lines. A diversity receiver connected to the antenna then chooses the strongest amongst these two combined signals for further processing. Each of the elements 202, 203, and 204 can also act as a transmitter provided that the transmitted signal is at a different frequency than the received signal.

A parasitic element 205 is supported and elevated by pairs of rod supports 206a and 206b. The parasitic element preferably acts as a de-coupling rod. The parasitic element is perpendicular to the vertical axis 215 of the array. The rod supports are constructed of a non-conducting material. Although one parasitic element is shown, it will be understood that the exact number of parasitic elements can be varied and depend upon the exact configuration and other required characteristics of the antenna.

Referring now to FIGS. 7 and 8, an array 310 of crossed, dual-dipole radiating elements 302, 303, and 304 are connected to a ground plane 301 to operate in the cellular band of frequencies of 820-960 MHz. As discussed above, the composition and dimensions of the ground plane 301 and radiating elements 302, 303, and 304 determine the radiation characteristics, beam width, and the impedance of the antennas.

6

The radiating elements 302, 303, and 304 transmit and receive electromagnetic signal transmissions and are comprised of pairs of dipoles, 311a and 311b, 312a and 312b, and 313a and 313b, respectively. The dipoles comprising the radiating elements 302, 303, and 304 are crossed and configured with 45 degree slant angles (with respect to the axis of the array 315). That is, the axes of the dipoles are arranged such that they are parallel with the polarization sense required. As shown, the slant angles  $+\alpha$  and  $-\alpha$  are +45 degrees and -45 degrees, respectively. Although shown with slant angles of +45 degrees and -45 degrees, it will be understood by those skilled in the art that these angles can be varied to optimize the performance of the antenna. A front side wall 307 and rear side wall 308 contribute to the radiation characteristics of the antenna.

Each of the radiating elements 302, 303, and 304 receive signals having polarizations of +45 degrees and -45 degrees. The received signals from parallel dipoles 311a, 312a, and 313a or 311b, 312b, and 313b, are combined using a feed network for each polarization. The feed network is composed of coaxial, microstrip, stripline, or other type of transmission line. A diversity receiver connected to the antenna then chooses the strongest amongst these two combined signals for further processing. Each of the elements 302, 303, and 304 can also act as a transmitter provided that the transmitted signal is at a different frequency than the received signal.

A first parasitic element 305a is supported and elevated by rod supports 306a and 306b. The parasitic element 305a is parallel to the vertical axis 315 of the array. Additionally, a second parasitic element 305b is supported and elevated by rod supports 306c and 306d. The parasitic element 305b is also parallel to the vertical axis 315 of the array and acts as a de-coupling rod. The rod supports are constructed of non-conducting material. Although two parasitic elements are illustrated in this embodiment, it will be understood that the number can be varied according to the exact configuration and operating characteristics of the array.

Thus, an antenna array is provided which is comprised of dual polarized radiating elements and produces two orthogonally polarized signals. Furthermore, the invention provides an antenna array where the antennas are comprised of crossed-dipole elements and which improves isolation between the electromagnetic fields of the crossed dipole elements. An antenna has also been provided which minimizes the number of antennas required in a wireless telecommunication system thereby providing an aesthetically pleasing structure that is of minimum size and scale.

While the present invention has been described with reference to one or more preferred embodiments, those skilled in the art will recognize that many changes may be made thereto without departing from the spirit and scope of the present invention which is set forth in the following claims.

We claim:

1. An antenna for simultaneously receiving separate electromagnetic signals comprising:

- a ground plane with a length and having a vertical axis along said length;
- a plurality of dipole radiating elements, said radiating elements comprised of first and second co-located, orthogonal dipoles, said dipoles aligned at first and second predetermined angles with respect to said vertical axis, said radiating elements and ground plane producing first electromagnetic fields in response to said electromagnetic signals;

8

prises an upper surface and said parasitic elements are positioned along an upper surface of said support.

9

23. The antenna of claim 19 wherein said plurality of supports is located adjacent to said radiating elements.

24. The antenna of claim 19 wherein said ground plane is composed of metal.

25. The antenna of claim 19 wherein said plurality of radiating elements includes exactly three radiating elements.

26. The antenna of claim 25 wherein said plurality of supports includes exactly two sets of supports.

27. A method for providing high isolation for an array of radiating elements comprising the steps of:

simultaneously receiving separate electromagnetic signals;

providing a ground plane having a vertical axis;

providing a plurality of dipole radiating elements, said radiating elements comprised of first and second co-located, orthogonal dipoles, said dipoles aligned at a predetermined angle with respect to said vertical axis, said radiating elements having a top surface;

producing first electromagnetic fields in said radiating elements responsive to said electromagnetic signals;

10

providing a plurality of non-conductive supports, and placing said supports parallel to said vertical axis and adjacent selected of said plurality of dipole radiating elements;

providing a plurality of independent metallic parasitic elements unconnected to said dipoles and placed in a selected of said plurality of supports;

exciting currents in said metallic parasitic elements;

creating second electromagnetic fields radiating from said parasitic elements; and

canceling with portions of said first electromagnetic fields with said second electromagnetic fields.

28. The method of claim 27 comprising the further step of placing said parasitic elements midway between the top surface of said radiating element and ground plane of selected of said housings.

29. The method of claim 27 comprising the further step of orienting the radiating elements at a predetermined angle with respect to the vertical axis of the array.

\* \* \* \* \*

09923943-0130501

add91 &gt;